Student questions: Alison Duvall colloquium on "Magnitude 9 Cascade subduction zone earthquake and landslides: How will the hill slopes handle the big one?"

4/10/19

Question 1: Did your team also assess the risk of volcanic activity playing a role in major landslides like mount rainier?

Unfortunately, no, the volcanoes were not part of our study. However, scientists at the USGS Cascades Volcano Observatory study the volcano risks.

Question 2: Is there any early warning equipment that we have developed that would help prevent high casualty?

We have made progress on earthquake early warning. The Pacific Northwest Seismic Network (PNSN) and the USGS are currently working on an app called ShakeAlert. It is in the testing/implementation phase.

Question 1: Have you noticed an increase in landslides in more developed areas compared to undisturbed ones?

People do trigger many landslides, thus it might be true that more developed areas have more landslides than undisturbed ones, but I don't know of any specific study of that topic.

Question 2: What are the key characteristics you measure when calculating slope stability and/or predicting the likelihood of a landslide?

Key characteristics for assessing slope stability are: **slope angle, material strength properties (cohesion + angle of internal friction), depth to the potential slide plane, and degree of saturation of water on the slope.**

Question 1: Could thermal remote sensing data in addition to lidar and surface roughness datasets be useful for determining the strength of the material (soil vs. bedrock) and how susceptible it would to coseismic landslides?

Hmmm, I'm not sure. I don't know of any current thermal remote sensing used in that way.

Question 2: How do urban planners in the Pacific Northwest engineer for the potential hazards that could be caused by coseismic landslides?

Urban planners aren't usually the ones in a position to do the engineering, but instead, they work with emergency managers to plan for the before/during/aftermath of a natural hazard event (for example, coseismic landslides). Structural / civil / Geotech engineers work on how to design buildings, bridges, and structures to withstand earthquakes and landslides.

Question 1: Why are they called sticky patches?

"Sticky patches" or asperities on faults are parts of the fault that were stuck or locked and hasn't had an earthquake in a long time, thus it is vulnerable to a large earthquake in the future.

Question 2: Why is the pacific northwest so susceptible to landslides?

The three main ingredients that make the Pacific Northwest so vulnerable to landslides are: 1) weak glacial deposits 2) high precipitation 3) steep slopes

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Question 1: How detailed were the parameters for modeling results with regard to the foundation design and other existing engineering aspects?

I'm sorry, I'm not sure I understand this question.

Question 2: Have you explored the effects or spatial extent of liquefaction over the region in your models?

I have not personally, but two scientists on our project are studying the spatial extent of liquefaction. They have found that the long duration of the M9 earthquake has a big impact and makes the area extra susceptible to liquefaction during Cascadia subduction zone earthquakes.

Question 1: Has the increase of wildfires in California over the past ten years affected the amount of landslides in the Cascadia subduction zone?

Fires definitely make the hillslopes more susceptible to landslides. If the next M9 hits northern CA soon, that would make a difference.

Question 2: Are there often problems with dating the roughness of landslides that have been subjected to repeated water flow, such as in river valleys?

Yes, that would affect the roughness dating technique. To avoid these complications, we cut out all rivers/gullies from our analysis.

Question 1: Regarding M9 quakes, how do you spark proactive instead of reactive solutions?

We need to create an "earthquake culture" in the Pacific Northwest as exists in CA (where earthquakes are a common part of life). Easier said than done when we have earthquakes so rarely in the PacNW (but the stakes are very high).

Question 2: What is the next step for the team after all findings are published?

Great question. We are working on obtaining funding right now to do the same kind of study for the Seattle Fault.

Question 1: Given that X-year events are independent of previous years, simply indicating that there is a 1/X chance that a given event will occur within a specific year, does that not mean that there is a very slight chance than an earthquake of such a magnitude will strike the pacific northwest within this year, or in any subsequent year?

It depends on the specific earthquake and its average recurrence interval.

Question 2: If the results of your research seem to indicate that the results of a new category 9 earthquake would be disastrous, and would likely occur soon, do you believe that locals would be willing to relocate or evacuate based on your data?

We don't need people to relocate, but we do need people to be prepared (earthquake kit, tsunami evacuation plan, etc.)

Question 1: Updating buildings to current codes can be financially demanding; do you know if Oregon has a plan or budget set in place to do this?

I do not know the status of Oregon's budgeting.

Question 2: You briefly mentioned this already, but is there a way to ease the public into the nature of your findings through digital platforms, such as social media, so that the information is not overwhelming all at once?

Yes, we are working on the best ways to inform the public of our results. Social media is one valuable outlet.

Question 1: How is the data for your project collected?

Many different methods. Some data comes from computer models, other data is observed in the field, or collected via surveys with the public.

Question 2: Will we be able to detect a landslide trigger in time for evacuation?

Possibly. Earthquake early warning can provide 30 seconds to a minute or so of warning. But that's not much time in terms of getting out of the way of coseismic landslides.

Question 1: Why do the glaciers on the edges trigger landslides?

Not sure what you are referring to here.

Question 2: Besides standard deviations, what are some other methods used to quantify roughness?

In addition to standard deviation of slope, we also quantify roughness using wavelet functions and Fourier transforms.

Question 1: Does studying and understanding Coseismic Landslides have an impact on emergency response if an earthquake occurs?

Yes, definitely. Coseismic landslides often cause more damage and casualties than the buildings/shaking in the actual earthquake.

Question 2: Are there areas in the United States that are more susceptible to Coseismic Landslides?

Yes, Pacific Northwest and CA.

Question 1: When discussing the impacts of an M9 with the city of Seattle it was mentioned that academic, public sector and non-profits were in attendance, were corporations (specifically construction sector) invited to attended the early meetings?

Yes, they have been invited, but we haven't made as much traction with the private sector (business) community as we would like. We are working on this.

Question 2: The histogram plot showing landslides in the coastal region of Oregon (Tyee Fm I believe it was called) showed higher than normal frequencies in the last 100 years; if not associated with earthquakes, what could they be associated with?

We aren't sure, but it could be storms, especially after the hillslopes were "primed" from the big M9 earthquake 320 years ago.

Question 1: Is it unlikely that new landslides will cover up older ones before they are found/dated?

It is possible that this happens commonly.

Question 2: Is there a risk for volcanic activity following an M9 earthquake?

Yes, that is a risk that others are studying.

Question 1: How reliable are standard calibration tables used for radiocarbon dating today?

It depends on where you are on the C14 timescale – uncertainties can be large over the last few hundred years for example.

Question 2: Why are the typical systematic uncertainties that need to be taken into account when constructing synthetic seismograms?

The key rupture parameters that I discussed.

Question 1: Why do you think risk management, urban planning, etc. people were not aware of the possibility of the M9 before the New Yorker piece?

The last event happened so long ago (over 300 years) and we (the geologists) didn't know that the Cascadia subduction zone had M9 quakes on it until about 30 years ago.

Question 2: How did the M9 team decide on Northern CA, OR, and WA as the extent of the scope of your study, and not further north or south?

That is the extent of the plate boundary that we know ruptured in 1700 AD.

Question 1: How long does it take to make an earthquake simulation?

About 1 week for each one on a super computer.

Question 2: Maybe i'm just new to this, but, what is headscarp exactly?

A landslide headscarp is a steep (nearly vertical) region of exposed soil and rock at the head of the landslide where the failure surface ruptures the ground surface.

Question 1: Would it be possible for the city to of seattle to set off controlled landslides?

No, I do not think that would be a good idea (risky!).

Question 2: Would coastal landslides that trigger tsunamis also affect tsunami early warning systems for ones caused by earthquakes?to warn the public?

Landslides can and do trigger tsunamis when they either flow into a body of water or occur under water. Not sure if they would be detected. It depends on where they originate.

Question 1: What are the wide range of hopes for collecting all of this landslide data?

We hope to find evidence of landslides that occurred during the last M9 earthquake in 1700 AND to use the timing and spatial distribution to both predict how the landslides will behave in the next big earthquake as well as to use the patterns to study subduction zone coseismic landslides in general.

Question 2: How often do deaths occur in Washington from mudslides due to or not due to earthquakes?

Deaths, in general, are not that common in WA landslides. However, the 2014 Oso landslide killed 43 people. This was the deadliest landslide in US history outside of Puerto Rico.

Question 1: Could landslide density vs pga be correlated to other subduction zones?

We are trying to learn from the Tohuku, Japan event and the Maule, Chile event (both subduction zones).

Question 2: Has any uplifting been recorded in the landslide data collection area?

There is evidence of uplift in the Oregon Coast Range. This evidence comes from river erosion and gps data.

Question 1: Generally speaking, how long do you expect evidence of coseismic landslide events to persist?

Depends on the landscape. The vegetation grows back very quickly in the Pacific Northwest, but it takes thousands of years for the landscape to smooth.

Question 2: Can earthquake swarms of lesser magnitude trigger similar coseismic events?

I don't think so, but I am not a seismologist, so I can't be sure.

Question 1: Could the unusual weather patterns, like increased or decreased rainfall, due to the current trend in climate cause a significant change in the amount of landslides due to earthquakes?

Not due to earthquakes, but unusual weather patterns can certainly affect precipitation-driven landslides.

Question 2: Will this data only be viable for subduction zone earthquakes that you talk about, or those of other earthquake types as well?

The specific data that I discussed is specific to subduction zone earthquakes.

Question 1: What makes Seattle more susceptible to both landslides and earthquakes compared to La Grande?

Seattle is more susceptible to landslides because of intense precipitation, steep slopes, and weak glacial deposits. It is more susceptible to earthquake shaking because it sits on the top of the Seattle basin, which amplifies seismic waves. It is also susceptible to earthquakes on a local fault – the Seattle Fault.

Question 2: What are the chances that an M9 earthquake will take place within the century and produce noteworthy landslides in the North-west region of the United States?

The chance of an M9 earthquake in the next 50 years is about 10 – 14%.

Question 1: How much displacement could potentially occur between the Juan de Fuca and North American plates if an earthquake that ruptured the entire length of the fault were to occur?

There might be 1 – 2 m of subsidence at the coast.

Question 2: Would landslides be likely on the great volcanoes of the Cascades in the event of an M9 earthquake, and, if so, could landslides beneath a heavily glaciated slope like those on Mount Rainier trigger significant and devastating flooding, like those that have occurred when glaciated volcanoes have erupted in the past?

Yes, that is a concern. The slopes of the volcanoes are particularly steep and unstable and flooding from glacial melt is also a significant hazard being considered.

Question 1: How many subduction zones do we have data to compare to the Oregon coast data?

There are many subduction zones around the Pacific "Ring of Fire" to compare to.

Question 2: In your topography smoothing simulation it was based on soil flux, what would happen if you based it on water flux or other geomorphological sources?

The smoothing happens in response to soil processes. Water moving over the landscape does the opposite of smoothing – it roughens the landscape from processes of gully and/or river valley development.

Question 1: How does a weaker earthquake generate worse landslides?

It's a lower magnitude, but the faults is a) closer to Seattle – it runs right through the heart of the city and b) it is shallower than the Cascadia megathrust.

Question 2: What is being done to prevent older buildings (100% of buildings built without the future codes) from collapse?

Sadly, nothing currently unless individuals choose to do it on there own.

Question 1: In the landslide model, the roughness always go down. Is it possible to consider process that make the roughness goes up?

The roughness always goes down for the soils of hillslopes unless a new event occurs. If you consider river erosion (instead of soil flux) that will make the roughness go up.

Question 2: When using M9 to help design buildings, do we consider resonance of different frequencies?

Yes, that is considered.